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No. 90

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UDC 534.1:533.6.013.424

VIBRATIONS OF CONTROLLED ELASTIC SYSTEMS CONTAINING FLUID

Moscow MASHINOVEDENIYE in Russian No 2, Mar-Apr 82 (manuscript received 24 Jul 81) pp 32-39

KOLESNIKOV, K. S., Moscow

[Abstract] Vibrations of an elastic system with closed-loop feedback control, namely of a rocket consisting of fuselage, engine and tank with liquid fuel, are analyzed by the method of system decomposition and subsequent reintegration. Transverse and longitudinal vibrations of the fuselage as well as attendant oscillations of the liquid are calculated from corresponding differential equations of motion for an axisymmetric nonuniform beam under axial compression and the Laplace equation of hydrodynamics for an ideal fluid respectively, with appropriate boundary conditions. The resultant natural modes and frequencies of the components are checked against physical models. The relation between components and their vibration modes is established on the basis of a first-approximation dynamic model of the entire system. The stability of this system is analyzed and the control requirements are determined on this basis. High-frequency oscillations of the liquid are found to be independent of the fuselage vibrations. Most unfavorable is the situation where the frequency of natural oscillations of liquid in the fuel main approaches that of natural longitudinal vibrations of the fuselage. Stability of the closed system is achieved by selection of engine regulators with appropriate dynamic characteristics and by means of various devices regulating the natural frequency of liquid in the fuel main. Figures 4, references 7 Russian.
[270-2415]

UDC 539.374

TOROIDAL SHELLS: STABILITY AND CATASTROPHIC FAILURES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 262, No 5, Feb 82
(manuscript received 29 Sep 81) pp 1086-1088

OBRAZTSOV, I. F., academician and VOL'MIR, A. A.

[Abstract] Stability of toroidal shells and their catastrophic failure through snapping under pressure are analyzed, first by the method of finite elements and then by the broader method of multilevel superelements (finite elements constituting zero-level superelements). A toroidal shell is in each case approximated as an array of truncated cones, superelements of various levels, interconnected along nodal circles. The subcritical state of stress of an ideal shell is assumed to be a zero-moment axisymmetric one. Solution of linearized equations of static stability as an eigenvalue problem with the geometrical stiffness matrix yields the wave pattern as well as the critical pressure. For real shells there is an upper level of critical pressure corresponding to almost zero initial deflection (irregularity) and a lower level of critical pressure corresponding to initial deflection equal to half the shell wall thickness. The critical pressure for precisely manufactured toroidal shells should lie between those two levels. The authors thank G. S. Pogosyan and K. Z. Khayrnasov for performing numerical calculations by the method of finite elements, also V. V. Novitskiy for discussing the problem. Figures 3, references 12: 9 Russian, 3 Western.
[287-2415]

CONFERENCE ON SEMISUBMERSIBLE DRILLING RIG CONTROLS

Leningrad SUDOSTROYENIYE in Russian No 7, Jul 82 pp 50-51

[Article by Yu. P. Chekrenev: "Conference on Control and Information Support for Semisubmersible Drilling Rigs"]

[Text] In 1981 in the city of Sumgait, the third coordinated conference on control and information support for semisubmersible drilling rigs [SSDRs] took place. It was organized by the Commission on the Theory and Methods of Controlling Systems for the Exploration and Exploitation of the World Ocean together with the Commission on Engineering Facilities and Methods of Exploring the World Ocean of the Scientific Council on the Problem of the Study of the Ocean and Seas and the Use of Their Resources of the GKNT [State Committee of the USSR Council of Ministers on Science and Technology], and with the Interdepartmental Coordinating Council for Leningrad of the USSR Academy of Sciences, the Ministries of the Shipbuilding and Gas Industries, the Ministry of Instrument Making, Automation Equipment,and Control Systems, and the Ministry of Higher and Secondary Education of the RSFSR.

The conference was conducted within the framework of the program of work on the problem of the "World Ocean" approved by the GKNT and in accordance with the decision of the First All-Union Conference on the Fundamentals of the Design of PPBU [Floating Semisubmersible Drilling Rigs (SSDRs)](in Sevastopol in 1978) for the purpose of evaluating the status of work on the control and information support for SSDRs and for the coordination of this work.

The following group of questions was considered at the conference: operating experience and trends in the development of semisubmersible drilling rigs, systems for determining the deviation of a rig from the drilling point and methods of presenting information based on microprocessors, analysis of mathematical models and algorithms of control, simulators for training SSDR operators, and others.

The conference was opened by corresponding member of the AzSSR Academy of Sciences Prof A. A. Abdulayev. He read a welcome to the conference participants from the chairman of the Scientific Council on the Comprehensive Problem "Cybernetics", Academician O. M. Belotserkovskiy. In his own remarks, A. A. Abdulayev noted the importance of the conference and the advisability of its being held in Sumgait, stressing that the Caspian is the original proving ground for testing new forms of equipment for offshore exploration and extraction of oil and gas.

Prof I. R. Freydzon, chairman of the Commission on the Theory and Methods of Controlling Systems for the Exploration and Exploitation of the World Ocean of the Scientific Council on the Comprehensive Problem "Cybernetics", came forward with a report on the work of the commission and on the aims of the conference. In his remarks he considered the features of a semisubmersible drilling rig as an object of control, and noted the complexity of the tasks confronting the conference.

Cand Tech Sci N. A. Badovskiy gave the report: "The Basic Directions of Technical Progress in the Building of Offshore Drilling Rigs Abroad". In it much data on foreign engineering facilities for offshore exploratory and production drilling was analyzed. For companies, a common striving was revealed for significant weight reduction in structures by the use of high strength materials, by the application of "maximum" design methods, by the use of computers, and by reducing the weight of supplied equipment. The technically achievable depth for exploratory drilling at present is 2440 m and in production drilling, 312 m. The most promising engineering facilities are: for drilling in shallow water - jack-up rigs, for drilling in depths of 150-610 m - rigs on tensioned anchor lines, and for drilling in 150-450 m depths of water - a variant of the Norwegian "tripod".

V. G. Fadeyev spoke on the development of monitoring and control systems for semisubmersible rigs and on engineering facilities for operations on the continental shelf. The report summarized domestic industrial experience in the development of instrumentation and control systems. The advisability was emphasized of developing a new progressive technology based on the use of a qualitatively new drilling bitt and a marine version of drilling production equipment with modern automated systems of control, and with instrumentation that will permit optimizing expenditures in driving a well under drilling conditions on the shelf.

Cand Tech Sci P. M. Aliyev gave the report: "A Positioning System for a Semisubmersible Drilling Rig Based on Microprocessor Technology and Programmed Data Display". He told about a technique for analytical investigation of the dynamics of an anchored SSDR in a stochastic environment and about a method of synthesizing an adaptive relay system, of given accuracy with the minimum number of switchings, for control of the nonlinear oscillation parameters of an anchored SSDR. On the basis of these techniques an automatic SSDR positioning system with a decentralized structure was developed on a base of domestic microprocessor technology.

A. Yu. Bal'zamov, Cand Tech Sci M. M. Levit and Prof I. R. Freydzon devoted their address to the modelling of the process of positioning a semisubmersible rig and the selection of the optimum control principle. The report set forth the structure of the fundamental nonlinear model of the motion of an SSDR with the use of an auxiliary linear model obtained by way of linearizing the vector equations of motion along the coordinates of the equilibrium position as well as the increments of the lengths of the paid out anchor lines. The modelling results showed that the obtained principle and algorithm of control provides the required SSDR positioning accuracy by a relatively simple means.

The report of T. V. Alova, Cand Tech Sci Yu. P. Chekrenev, and Cand Tech Sci S. O. Shaposhnikov, "The Construction of a Simulator for Training SSDR Operators" was devoted to the need to create simulators for training SSDR operators in

operations under normal and emergency conditions. Methods of building a simulator were discussed and the structure of an adaptive simulator was presented.

A. Ye. Kozyaruk presented a report on "The Electrical Equipment of the Positioning Systems of Floating Drilling Rigs" which told about the results of an investigation of the construction of the control algorithm and composition of electric drives for anchor windlasses and also of the algorithm for the interconnection of the electric drives with the central control system. The composition of the regulating system for the electric drives was defined on the basis of a synthesis of a linearized system by use of the principles of successive corrections. The control algorithm, providing for optimization according to the criterion of minimum loss, was based on methods of nonlinear programming in a real time scale. The report considered open and closed positioning systems based on microcomputers of the "Elektronika S5" series.

To questions of the composition of systems for finding the position of a semisubmersible drilling rig were devoted the reports of Prof A. T. Barabanov and D. A. Kainov: "Systems for Finding the Position of an SSDR", T. R. Rekhel's: "Questions of the Composition of Hydroacoustic Devices for Finding the Position of an SSDR Relative to the Well Head", and of Cand Tech Sci M. Sh. Guseynov: "An Inclinometric Positioning Device". Cand Tech Sci G. M. Safronov, Cand Tech Sci S. D. Osmanov, and R. Z. Sultanov presented a report on "Automating the Electric Drives of Anchor Windlasses on an SSDR".

Conference participants held an out-of town session on board the first domestic semisubmersible drilling rig "Shel'f-1". They inspected the rig's equipment and systems and met with the oilmen. Specialists exchanged opinions about the chosen technological modes for positioning the rig and about the adopted structural and design decisions. Conference participants noted the advisability of introducing the following levels of automation:

- for rigs operating in depths up to 200 m, a centralized remote control of the anchoring system with well-developed means for presenting information to the operator and, later on, introduction of a device for generating recommendations about the control of an SSDR's condition.

- for rigs operating in depths up to 500 m, automated control of the positioning system.

In addition, the need was emphasized for developing devices for the generation of recommendations about the control of the condition of a semisubmersible drilling rig and for developing simulators for teaching and training operators in order to assure efficient operation of SSDRs at depths up to 200 m. It also is necessary to coordinate the principal technological solutions for offshore drilling processes with the systems being developed for monitoring and controlling the condition of an SSDR.

The conference recommended:

- developing theoretical, applied, and experimental investigations and experimental-design research in the field of the theory and methods for controlling complex, multiply-connected dynamic objects with regard to information support for control processes,

- development of scientific bases for the construction of mathematical models, algorithms, and control systems based on microprocessors for the positioning of SSDRs taking account of irregular wind and wave disturbances,

- development of man-and -machine systems, methods of selecting operators, and adaptive systems for teaching SSDR operators,

- organization of full-scale investigations of operating units to determine the dynamic characteristics of the object of control,

- studies of operating experience on the first domestic SSDRs to determine the performance indices of the various types of control systems,

- development of a unified comprehensive system for obtaining, assembling, processing, and displaying information for SSDRs taking account of new methods and principles of constructing systems for assuring highly reliable operation.

It was acknowledged as advisable, in the development of the programs for the creation of engineering facilities for finding and exploiting oil and gas deposits on the shelf, to prepare a comprehensive plan of proposals in a section for the development of the theoretical bases and principles of construction and the creation of a modelling scheme and monitoring and control systems for SSDRs.

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PERFORMANCE ANALYSIS OF SOLAR HEAT PLANT WITH HEAT PUMP SYSTEM

Moscow KHOLODIL'NAYA TEKHNIKA in Russian No 6, Jun 82 pp 46-49

PONOMAREV, V. N., candidate of technical sciences, TYUTYUNNIKOV, A. I. and MOSYAGIN, V. Yu., Leningrad Higher Engineering Construction School imeni Arm Gen A. N. Komarovskiy

[Abstract] Operation of a solar heat plant in combination with heat pumps is optimized through performance analysis on basis of functional and mathematical models of its components for an overall system criterion functional. The plant consists of a solar heat collector, a storage tank, an evaporator, a condenser, a pump between collector and tank, a pump between tank and evaporator, a compressor and a thermostat between evaporator and compressor, a pump and a peak-load preheater in the distribution line behind the condenser. Calculations are based on power and efficiency relations for each component, coolant characteristics, equations of energy balance, statistical data and multivariate regression analysis. Cost comparisons are made for typical operating conditions (temperatures) between such a plant with standard components and coolant and a regional boiler plant. Figures 4, tables 1, references 8 Russian.
[277-2415]

UDC 621.577-67

HYBRID SOLAR PLANT AND HEAT PUMP SYSTEM FOR HEATING AND COOLING

Moscow KHOLODIL'NAYA TEKHNIKA in Russian No 6, Jan 82 pp 43-46

DARCHIYA, G. I., RATIANI, G. V., professor, and KHUNTSARIYA, R. K., candidate of technical sciences, and UNGIADZE, N. M., Georgian Polytechnic Institute imeni V. I. Lenin; Georgian State Institute for Planning of Cities and Construction

[Abstract] A hybrid system consisting of a solar heat plant with collector on the roof and two heat pumps with storage tank has been designed for year-round heating and cooling of the Pitsunda health resort housing 300 people.

The load there is 580 kW for heating and ventilation; 186 kW for hot water supply, and 700 kW for heating sea water in the swimming pool. Five variants of solar heat collector (surface area varying from 2000 to 6000 m^2) and heat pumps were evaluated comparatively with respect to annual cost and energy consumption. They were also compared with a system of heat pumps alone and with a conventional system consisting of electric boiler for winter and air conditioner for summer. Both operating and investment costs were included in the analysis, the latter covering also four refigerators. The combination of two heat pumps and solar heat collector with 3000 m^2 surface area has been selected, it saves 300,000 kW·h of electric energy of 15,000 rubles annually and costs 87.6 rubles annually to operate, although the system with heat pumps alone costing only 80.6 rubles annually would be the most economical one. Figures 1, tables 2, references 1 Russian.
[277-2415]

UDC 621.56+546.291

CRYOGENIC HELIUM SYSTEMS FOR CIRCULATION-TYPE AND IMMERSION-TYPE SUPERCONDUCTING MAGNETS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 82 (manuscript received 30 Jun 81) pp 3-13

BELYAKOV, V. P., Moscow

[Abstract] Cryogenic helium systems for cooling superconductor winding of magnets are either single-loop or double-loop ones. In a single-loop system cryostat and magnet are coupled through one total helium stream, which is thermodynamically very efficient but not suitable for variable-load operation because of high inertia. In a double-loop system there are two separate helium streams, one through the cryostat and one through the magnet, which facilitates fast adjustments to load changes but is less efficient on account of additional losses. Magnets of elementary-particle accelerators are cooled with helium circulating through hollow superconducting magnet coils. Magnets of MHD generators are cooled by simple immersion of the superconducting structure in boiling helium. The first method of cooling is used in the Tokamak-15 nuclear fusion plant, with a universal experimental cryostat installed which consists of a nitrogen-vapor condenser and a double-loop helium cryostat. There is also an ORG-250 1200/4.5 facility available consisting of three tanks for helium purification cooling and liquefaction respectively. The universal cryostat is sufficiently large and versatile to provide cooling for the magnets which produce the toroidal magnetic field and the magnets involved in microwave heating. Immersion-type and circulation-type magnets can be tested here. The characteristics of helium as coolant necessary for these operations are determined from the Steckly stability criterion and the Nusselt heat transfer criterion for supercritical boiling helium. A computer-aided solution of the standard equation of hydrodynamics on this basis reveals that any reliable cryogenic cooling of circulation-type superconducting magnets and maximum possible cryogenic cooling of immersion-type suprconducting magnets can be achieved only with superfluid helium He-II. Figures 7.
[276-2415]

UDC 621.3:538.3.001

MOTION OF CONDUCTORS IN PULSATING MAGNETIC FIELD OF FLAT INDUCTOR

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 2, Mar-Apr 82 (manuscript received 7 Feb 80, after revision 7 Jan 81)
pp 130-138

MIKHAYLOV, V. M., Khar'kov

[Abstract] Electromagnetic field equations conforming to Kirchhoff's second law are formulated for a flat spiral multiturn inductor above a die, in a plane parallel to the surface of the latter, which generates a pulsating magnetic field causing a plate in the gap between the two and parallel to both to move horizontally. First all three elements of this system are assumed to be made of nonmagnetic conducting materials, the inductor to be energized by discharges from a capacitor, and all points of the plate to be moving at the same velocity which varies in time but remains much lower than the velocity of light. Upon replacement of electric field intensities with equivalent magnetic field intensities in the original two differential equations, the latter are reduced to two integro-differential ones and these then converted on a time grid to a system of n algebraic equations (n-number of nodes in the time grid). Analysis of the problem continues with one of the conductors, die or inductor respectively, assumed to have ferromagnetic properties characterizable by differential permeability. In the case of a ferromagnetic inductor the motor equations are solved, taking into account diffusion of the magnetic field and Newton's second law, for a heavy plate made of a homogeneous nonmagnetic conducting material and for a plate made of a conducting bimetal on a heavy nonmagnetic base. The presence of the die is first disregarded and then included. Solution on an M222 computer based on recurrence relations for difference analogs of integrals and derivatives on the time grid converges after a few iterations. Figures 4, tables 2, references 13 Russian.
[276-2415]

UDC 533:538+550:38

GENERATION OF CURRENTS AND ELECTRIC FIELDS IN VICINITY OF NONCONDUCTING ROTATING SPHERE IMMERSED IN HOMOGENEOUS PLASMA IN STRONG MAGNETIC FIELD

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 1, Jan-Feb 82 (manuscript received 5 Nov 80) pp 10-15

PIVOVAROV, V. G., Krasnoyarsk

[Abstract] Motion of the plasma in vicinity of the rotating earth with attendant currents and electromagnetic fields generated by this rotation is analyzed on basis of a model where a dielectric sphere containing a magnetic

dipole at the center and surrounded by a homogeneous incompressible conducting fluid rotates at some constant angular velocity about the axis of the dipole moment. All perturbations due to this rotation are assumed to decay with increasing distance from the sphere. The normal component of the current vanishes and the conditions of adhesion are satisfied at the surface of the sphere. The corresponding MHD equations are solved for the plasma in the boundary layer (large radial gradients of velocity components) and in the core region (quasi-isotropic rates of change of velocity components), upon replacement of the large Hartmann number Ha with the small parameter $\varepsilon = 1/HA$. The results reveal the structure of the Hartmann layer, its thickness increasing from minimum at the poles to maximum at the equator, as well as the behavior of currents and forces within this layer, outside it and at its boundary. References 6 Russian.
[283-2415]

UDC 538.4:621.365.21

MAGNETIC CUMULATION GENERATORS WITH OUTPUT TRANSFORMERS

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 1, Jan-Feb 82 (manuscript received 26 Nov 80) pp 4-10

BUKHAROV, V. F., VASYUKOV, V. A., GURIN, V. Ye., ZENKOV, D. I., KRAVCHENKO, A. S., LYUDAYEV, R. Z., PAVLOVSKIY, A. I., PLYUSHCHEV, Yu. I., PLYASHKEVICH, L. N. and SHUVALOV, A. M., Moscow

[Abstract] Transformers at the output of magnetic cumulation generators for applications such as charging high-speed capacitive storage devices make it possible to connect several generators into cascades with a resulting high energy gain and with capability of using suitable commutators to regulate the timing of energy transfer to the load. Ironless transformers are used here, to ensure maximum coupling and minimum losses in high-intensity magnetic fields. Most promising designs are coaxial and helical generators, or combinations of both, with current leads in form of plates at the periphery for connecting the primary of a toroidal solenoidal transformer, a sectoral cable transformer, or a two-turn cable transformer. The intricate geometry of such transformers makes analytical engineering design of these generator-transformer systems difficult, making it necessary to solve the model equations by numerical methods and to rely on experimental prototype data. Design parameters and performance characteristics of three magnetic cumulation generators are given for operation with output transformers: K-80 (75 kV, $0.02 \cdot 10^{12}$ W peak power, 2.5 kJ initial energy, 0.5 MJ final energy, 0.25 MJ energy in inductive load), K-160 (210 kV, $0.12 \cdot 10^{12}$ W peak power, 200 kJ initial energy, 5.1 MJ final energy, 3 MJ energy in inductive load), K-320 (100 kV, $0.5 \cdot 10^{12}$ W peak power, 1800 kJ initial energy, 31 MJ final energy, 20 MJ energy in inductive load). Figures 6, table 1, references 12: 9 Russian, 3 Western.
[283-2415]

UDC 621.007.52

USE OF ADAPTIVE INDUSTRIAL ROBOTS FOR CERTAIN TASKS IN MACHINE MANUFACTURE

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 5, May 82 pp 3-8

OSTAPCHUK, V. G., candidate of technical sciences, KANAYEV, Ye. M., candidate of technical sciences, and NIKOLAYEV, A. A., engineer

[Abstract] The most difficult task in operation of metal cutting machine tools is pickup of randomly oriented parts from the bin. This problem can now be solved with the "Adam 02" adaptive industrial robot, which has six degrees of freedom available for retrieving cylindrical parts, determining their position and orientatio , then positioning and orienting them as required in special trays. This robot is driven by d.c. motors, velocities up to 0.2 m/s and a positioning accuracy within 2 mm being attainable. Industrial robot UM160 (160 kg load capacity) with an ASVR 01 automatic robot drive system is capable of picking blanks from a flat single-layer heap for a lathe. Industrial robots UM40F4 and UM40F2 (40 kg load capacity both) are capable of picking blanks from flat multilayer heaps, both according to the same algorithm but the former in rectangular coordinates and the latter in intricate spherical coordinates. Adaptive industrial robots for assembly operations include the RV50F2 (40 kg load capacity, 0.1 mm positioning accuracy) with electrohydraulic drives for three degrees of freedom and the UM1.25F4 (1.25 kg load capacity) with d.c. and electric stepper motor drives. All these industrial robots offer a selection for a wide range of applications in automatic metal cutting, their efficiency and reliability depending principally on the software. Figures 6, references 5 Russian.
[280-2415]

UDC 62-50:531.3

ROBOTICS SYSTEM FOR AUTOMATIC ADDRESSING OF PARTS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 6, Jun 82 pp 15-16

YEROSH, I. L., doctor of technical sciences, and ZHABOTINSKIY, Yu. D., candidate of technical sciences

[Abstract] A robotics system has been introduced in the Kirov Works production department for automatic addressing of large parts. It consists of a parts

identifier, a control computer complex, an automatic addresser, a conveyer belt, two auxiliary conveyers (horizontal and vertical) and a main transport module. The parts identifier includes pulse generating and synchronizing circuits with counter and logic, a bank of signal amplifiers, seven photoreceiver arrays, seven lamp arrays, and two stabilized low-voltage power supplies (591-86 and BP1AN). The sequence of identification operations follows a cyclogram. The computer part of the identifier, including a memory and flip-flops, consists of 45 series K133 integrated-microcircuit chips. A typical code table is shown for airplane parts (wings, cabin, fuel tank, oil tank, etc). The identifier costs not more than 400 rubles. Figures 3, tables 1.
[289-2415]

UDC △ 62-229.7:534.282

SELECTION OF DAMPER CHARACTERISTICS FOR AUTOMATIC MANIPULATORS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 6, Jun 82 pp 11-12

GUSLITS, V. M., candidate of technical sciences

[Abstract] Dampers, devices for absorption of energy or more precisely for converting kinetic energy to heat, must be selected for specific applications on basis of their force-displacement characteristics with the temperature factor taken into account. These criteria apply to frictional (solid) and viscous (fluid) dampers for use in automatic manipulators. A test stand for damper evaluation and selection purposes has been built at the Scientific Research Institute of Farm Tractor Machinery, a physical model of the moving part of an automatic manipulator with dampers, which provides for load variation over a wide range with facilities for continuous recording of all performance parameters. A carriage loaded with a set of standard weights 36-80 kg simulates the moving manipulator component, with pneumatic drive and velocity regulation over the 0.4-2 m/s range. The instrumentation includes a displacement transducer, a force transducer, two pressure transducers, a d.c. tachometer generator, a seismic-type accelerometer, two signal amplifiers and a light-beam oscillograph. The force and pressure transducers are calibrated statically against a manometer, the accelerometer is calibrated against gravity, and the tachometer is calibrated by a special method. This method is not described here, but typical test results in form of velocity osillograms are shown which have been taken with a simulator of the AM R-505 manipulator arm. Figures 2.
[289-2415]

UDC 621.9.077

TECHNICAL SYSTEMS WITH MULTIOPERATOR ROBOTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 4, Apr 82 (manuscript received 20 Oct 80) pp 131-134

KORSAKOV, V. S., doctor of technical sciences, professor, and
CHECHETKOVICH, A. A., engineer

[Abstract] A multioperator robot is designed to work with the maximum possible number of machine tools in an industrial production process so as to ensure a productivity level not attainable by a robot operating a single machine tool only. Such a robot must also be reliably and flexibly controllable. A performance analysis of industrial robots has revealed that the manipulator arm is the essential element of any technological system which also includes a device for precise spatial positioning of parts, a drive mechanism for moving the robot along its prescribed route, and a programmable system of digital control. Least time-efficient and versatile is a one-arm robot, inasmuch as it can function only sequentially. Both efficiency and versatility increase as the number of manipulator arms of a robot is increased to two and three, the optimum number being four. With other factors such as fraction of overall idle time and cost of programmable digital control also taken into consideration, increasing the number of manipulator arms beyond four has been found to decrease the cost effectiveness of a multioperator robot. Figure 1.
[271-2415]

UDC 62-501.72

TRANSIENT PROCESSES WITHIN WORK ZONE OF AUTOMATIC MANIPULATOR

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 6, Jun 82 (manuscript received 2 Jun 81) pp 43-46

YUSHCHENKO, A. S., candidate of technical sciences, docent, and
RUSETSKIY, A. Yu., student

[Abstract] An algorithm is constructed for an automatic manipulator enabling it to automatically analyze transients and determine their stability distribution within the work zone. The basis is the equation of motion of a manipulator $A_0\bar{\ddot{q}} = \bar{\mu}$, linearized in the vicinity of a given point $\bar{x}_0 = f(\bar{q}_0)$ and reduced to normal Cauchy form (x_0 - 6x1 vector whose first three components define the location of the center of mass and last three components define the angular orientation of manipulated object, q_0 - Nx1 vector of generalized coordinates of manipulator, $A_0 = A(\bar{q}_0)$- NxN matrix depending on masses and moments of inertia of manipulator links, μ - Nx1 matrix of torques developed by manipulator drive motors). With det $A_0 \neq 0$, the corresponding eigenvalue

problem is solved for stability $\max_{i \in (1, M \div 2N)} \mathrm{Re}\,\lambda_i < 0$. The algorithm has been programmed in FORTRAN-4, and is demonstrated here on a typical example where the zone of optimum transient performance can be established on this basis. Figures 2, references 3 Russian.
[274-2415]

UDC 621.923

DEBURRING OF PARTS BY MEANS OF TOOL WITH MOVING (ROCKING) CUTTER SURFACE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 12, Dec 81 (manuscript received 8 Jul 80) pp 85-88

MAN'KO, V. F., graduate student

[Abstract] Deburring of parts for minimization of surface roughness with attendant increase of microhardness and residual compressive stresses is conventionally done by means of a stationary indenter. Rocking the indenter during operation will result in lower cutting temperature at the contact surface and thus prevent development of tensile stresses in the fabricated piece. This is demonstrated by analysis of the thermal state as well as stresses and surface finish, all depending on indenter feed velocity and rocking frequency. Calculations including the Peclet number, and experimental data on steel bushings treated with an indenter at rocking velocities from 0.08 to 5.0 m/s and rocking frequencies from 0.1 to 40 Hz, indicate that the mean contact temperature drops by up to 30% as the rocking velocity is increased from zero to 10% of the feed velocity and then at a rapidly decreasing rate as the rocking velocity is increased further. Higher rocking velocities are also not advisable, because high frequencies are required for limiting the amplitude and vibrations are likely to occur. Figures 3, references 2 Russian.
[286-2415]

UDC 621.924

ABRASIVE ACTION DURING GRINDING OF BUSHINGS ON BOTH OUTSIDE AND INSIDE SURFACES WITH LOOSE ABRASIVE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 12, Dec 81 (manuscript received 13 Mar 80) pp 81-85

MARTYNOV, A. N., candidate of technical sciences

[Abstract] A new method of grinding bushings on both outside and inside surfaces simultaneously has been developed at the Penza Polytechnic Institute. Loose abrasive is compacted inside a rotating drum by centrifugal forces

while a bushing held between a mandrel and a pressing roller, and partially immersed in the abrasive powder, is set in forced rotation so that both its surfaces move relative to the abrasive mass. The abrasive action in this device is analyzed on the basis of balance of tangential forces and normal forces respectively, forces of inertia playing an important role here. The intensity of abrasive action can be regulated through the speed of the drum. This action, in terms of pressure, is evaluated by solving the transcendental differential equation of motion for a particle along either bushing surface in the given geometrical configuration. This equation is solved by linearization, with a constraint on the maximum change of angular width of the abrasive layer inside the bushing. Experimental evaluation of this grinding method indicates that pressures of 0.1-0.15 MPa and circumferential velocities of the bushing within the 2-4 m/s range yield satisfactory results. Figures 2, references 4 Russian.
[286-2415]

UDC 621.43.018.3

POSSIBLE WAYS TO IMPROVE DIESEL ECONOMY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 5, May 82 (manuscript received 29 Jan 81) pp 86-90

YEVENKO, V. I., doctor of technical sciences, professor

[Abstract] The theoretical process cycle of a four-stroke diesel engine with constant-pressure air supercharge is analyzed for ways to improve the thermal efficiency and thus the engine economy. Two different schemes of coupling between turbocompressor and piston engine are considered and the mean effective pressure in each case is calculated for various combinations of maximum pressure and parameter $B=\varepsilon^{k-1}[\lambda - 1 = k\lambda(\rho - 1)]$ (ε cycle compression ratio, λ compression during constant-volume heat intake, ρ expansion during constant-pressure heat intake, k adiabatic exponent). The scheme with diverting of excess power from the turbine is found to be more economical than the scheme with free turbocompressor. Constant-pressure super-charge with pulse conversion should pull the ratio of cylinder outlet pressure to cylinder inlet pressure below the otherwise optimum $\varkappa = 2$ and thus ensure that the pressure of residual gases in the cylinder will not be excessive. The feasibility of increasing the maximum effective pressure to 14 MPa and parameter B to 4.8 in such a scheme with $\varkappa = 0.9$ is demonstrated by numerical calculations using $\lambda = 1.3$ and $k = 1.362$ as typical. Figures 3, references 3 Russian.
[273-2415]

UDC 536.241-621.313

MATHEMATICAL SIMULATION OF THERMAL STATE OF CRYOTURBOGENERATOR ROTOR

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 82 (manuscript received 13 Jul 81) pp 70-78

GLEBOV, I. A., DUL'NEV, G. N., POTYAGAYLO, A. Yu. and SIGALOV, A. V., Leningrad

[Abstract] A mathematical model of a cryoturbogenerator rotor has been constructed for analysis of its thermal state under steady transient conditions.

It is a one-dimensional model which corresponds to an idealized axisymmetric structure of such a rotor with a cryogenic cooling zone (field coils), two thermal bridges, thermal shield and electromagnetic shield. The temperature field in the cryogenic cooling zone is described by the equation of heat balance and the law of energy conservation, taking into account radial and axial heat influx as well as heat transfer to coolant. The temperature field in thermal bridges is described by the equation of heat condition, taking into account convective heat transfer to coolant and radiative heat transfer to both shields. The temperature fields in the latter are described by respective equations of heat conduction, taking into account radiative heat transfer from one cryostat shell to another and from heat exchanger to ambient medium. Boundary conditions are stipulated to "cold" and "hot" ends as well as at outside contact surfaces, joints between structural components assumed to be isothermal. The initial condition for all components is ambient temperature. The temperature dependence of thermophysical properties of structural materials and of coolant is stipulated by relations approximating experimental data. Local heat transfer coefficients are represented by appropriate Nusselt numbers for turbulent, transitional and laminar flow. The six nonlinear differential equations of this model, with five boundary conditions, were solved numerically by the difference method according to universal algorithms based on theory of graphs. The necessary flow rate of coolant, helium, was calculated from the corresponding transcendental equation of heat balance, disregarding thermodynamic processes in the coils in the field of centrifugal forces. The results were then used to calculate the two-dimensional temperature field of the rotor, and a Monte-Carlo method was used to establish the tolerance limits for errors in input data (initial and boundary temperatures, helium rate) representing random quantities uniformly distributed over given intervals for 80% of the realizations with 95% confidence coefficient.
Figures 5, references 13: 12 Russian, 1 Western.
[275-2415]

THERMAL STATE OF ACTIVE ELEMENT DURING INTERMITTENT OPERATION OF PULSE LASER WITH CLOSED COOLING SYSTEM

Kishinev IZVESTIYA AKADEMII NAUK MOLDAVSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian No 1, Jan-Apr 82 (manuscript received 25 Nov 80) pp 64-67

SAMOYLOV, M. S., KUZNETSOV, S. M., NEKRASOV, A. K. and PLAKHOV, A. I.

[Abstract] Intermittent cooling of the active element in a pulse laser with closed cooling system allows the coolant temperature to rise without requiring larger equipment. Here the successive heating-cooling cycles are analyzed on basis of exponential transients and final quasi-steady state. The differential equation of heat conduction is solved for appropriate boundary conditions of the third kind and the initial condition of temperature at end of pumping equal to temperature at start of subsequent cooling. Calculations are shown for a duty cycle with cooling time much longer than heating (pumping) time. Experimental data have been obtained with a 6.3x70 mm YAG element optically pumped from an IFP-2500 lamp and cooled by 2 kg of water. Figures 4, references 5 Russian.
[288-2415]

UDC 621.3.038.612

ION SOURCE WITH MICROWAVE POWER SUPPLY

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian No 2, Mar-Apr 82 (manuscript received 24 Mar 81) pp 3-4

MOLCHANOV, V. K. and SAVCHENKO, O. Ya., Novosibirsk

[Abstract] An ion source is described with regulation of energy through microwave power supply. It consists of a resonator excitable in the E_{010}-mode with a capillary gas-discharge tube along its axis and with a vacuum cavity, hydrogen gas serving as the plasma source. It also includes an electrostatic lens between two diaphragms and a Faraday cylinder for shaping the ion beam. It has been designed for and tested in operation at 2750 MHz (3 μs pulse duration) with continuous gas admission and at 1818 MHz (8 μs pulse duration) with intermittent gas admission. In the latter case it is possible to generate ion beams

with up to 30 keV energy, up to 18 keV at electric field intensities up to 50 kV/cm. The capillary tube is 3 mm in diameter, a gas utilization factor of 70% and an almost 100% degree of ionization being attainable here. Figures 5, references 2 Russian.
[284-2415]

UDC 537.52:533.9.01

BREAKDOWN VOLTAGES FOR INERT GASES AT 300-2000 K

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 1, Jan-Feb 82 (manuscript received 4 Dec 80) pp 20-27

BOZHKO, I. V., GLAZKOV, N. I., TROITSKIY, S. R. and FAL'KOVSKIY, N. I., Kiev

[Abstract] Departure of inert gases, argon (99.98% pure) and helium (99.99% pure), from Paschen's law with increasing temperature was studied experimentally over the 300-2000 K range under atmospheric pressure at standstill. Discharges were produced between electrodes 20-30 mm in diameter made of platinum and platnium-rhodium alloy, zirconium dioxide (900-2000 K in Ar) and aluminum oxide (1600-2000 K in Ar). The breakdown voltage was measured as a function of temperature at various interelectrode distances and as a function of interelectrode distance at various temperatures. The experimental data fit the empirical relation $V_{bd}=Aps = B\sqrt{ps}$ (s- interelectrode distance, ρ- density of gas referred to standard conditions, A and B numerical coefficients depending on temperature range and p.s range). The authors also measured the temperature dependence of initial current density after breakdown, the current-voltage characteristic of transition to glow discharge, and dependence of the ignition voltage on interelectrode distance at constant current density. The results indicate that the electric strength of argon and helium obeys the generalized Paschen law up to 1400 K and 1600 K respectively. Figures 6, references 16: 13 Russian, 3 Western.
[283-2415]

UDC 621.526

SUCTION OF GAS STREAM THROUGH IMPELLER CHANNEL OF TURBOMOLECULAR VACUUM PUMP

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 5, May 82 (manuscript received 7 Jan 81) pp 81-86

DEMIKHOV, K. Ye., candidate of technical sciences, docent

[Abstract] Suction of a gas stream through the impeller channel of a turbomolecular vacuum pump is analyzed as a three-dimensional process, assuming free-molecular motion of gas particles with Maxwell distribution of thermal velocities and diffuse reflection of particles by interaction surfaces (channel walls). The transport of gas molecules in two stages from high-pressure side to low-pressure side is evaluated on this basis, taking also into account the nonuniform transfer probability distribution over the cross section of a passage between impeller blades. The results are useful for design of impeller wheels. Figures 3, tables 1, references 3 Russian.
[273-2415]

UDC 533.6.011:539.196.6

SOME RELATIONS CHARACTERIZING EQUILIBRIUM FLOW OF DISSOCIATING GAS THROUGH TURBINE PASSAGES IN NUCLEAR POWER PLANTS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 42, No 6, Jun 82 (manuscript received 30 Mar 81) pp 982-987

ORUDZHALIYEV, E. A., Azerbaijan Institute of Petroleum and Cnemistry imeni M. Azizbekov, Baku

[Abstract] The generalized Bernoulli equation of equilibrium flow with friction and the equation of thermodynamics $TdS = c_p dT - T\left(\frac{\partial v}{\partial T}\right)_p dp$ are solved for a nonideal dissociating gas $pv = f(p,T) = Z_{dis}\frac{R}{\mu}T$, taking into account the first law of thermo-dynamics and variability of the molecular mass u. Relations are established on this basis for the work developed by steam and the isentropic or avilable enthalpy in a turbine of a nuclear power plant. References 4 Russian.
[272-2415]

UDC 532.529

EXPERIMENTAL STUDY OF FLOW OF SUPERSONIC TWO-PHASE STREAM AROUND BODIES

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 2, Mar-Apr 82 (manuscript received 14 Jan 81) pp 66-74

ALKHIMOV, A. P., NESTEROVICH, N. I. and PAPYRIN, A. N., Novosibirsk

[Abstract] Flow of supersonic two-phase streams around bodies was studied experimentally in a test stand including a laser-Doppler velocity meter with direct spectral recording of Doppler frequency shifts. The equipment consisted of an LG-159 one-frequency Ne-He laser, a translucent beam splitter, a rotatable mirror with 100% reflection coefficient, a polarizer regulating the intensity of the reference beam, two focusing lenses, a receiver aperture diaphragm, a collecting lens, a matching objective, a confocal multibeam interferometer with output photomultiplier, and an oscillograph. Gas at pressure $p_0 = 8.5 \cdot 10^5$ Pa and temperature $T_0 = 260$ K in a chamber was converted to a stream by means of a flat nozzle, the velocity reaching $M_{oo}=3$ at the nozzle throat. Particles of various materials (densities) and mean diameters were injected into the gas stream: bronze $\rho = 8.6$ g/cm^3 and $d_m = 100$ μm, acrylic plastic $\rho = 1.2$ g/cm^3 and $d_m = 200$ μm, aluminum $\rho = 2.7$ g/cm^3 and $d_m = 15$ μm, club moss powder $\rho = 0.5$ g/cm^3 and $d_m = 25$ μm. Model bodies (cylinder, wedge, sphere, cone) made of bronze or stainless steel were placed near the nozzle throat. Measurements were made by optical methods, interaction of shock waves with incident and reflected particles was examined on shadowgrams. The results agree closely with theoretical calculations. Perturbations of the forward shock wave by particles bouncing off the body surface appears to play an important role in the flow process and pattern when the bouncing distance is larger than the distance from head of forward shock wave to body surface. Figures 6, tables 1, references 15: 10 Russian, 5 Western.
[284-2415]

UDC 533.6.01+536.24

THERMOCHEMICAL BREAKDOWN OF GRAPHITIZED CARBON BODY IN HYPERSONIC GAS STREAM

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 2, Mar-Apr 82 (manuscript received 19 Feb 81) pp 58-66

BERTSUN, V. N., GRISHIN, A. M. and ISMAILOV, N. G., Tomsk

[Abstract] Thermochemical breakdown of an electrographite body initially conical with a spherical tip in a hypersonic air stream is analyzed, assuming a Reynolds number $Re_{oo} \gg 1$ in the oncoming stream and a frozen boundary layer at the surface. The air, a four-component mixture (O, O_2, N, N_2) is in thermodynamic equilibrium at the outer surface of the boundary layer, the inner surface of the boundary layer is either isothermal or adiabatic with negligible

heat leakage across the layer, and seven heterogenic processes ($C+O \rightarrow CO_2$, $C+O_2 \rightarrow 2CO$, $C+O \rightarrow CO$, $C+CO_2 \rightarrow 2CO$, $C(solid) \rightleftarrows C(gas)$, $O+O+C \rightarrow O_2+C$, $N+N+C \rightarrow N_2+C$) occur at the body surface. The corresponding boundary-value problem includes the equation of heat conduction through the solid phase and the equation of surface geometry, each with appropriate initial conditions. It is solved on the basis of mass balance and conventional relations for the molar-volume process rates $U_j = k_j \frac{c_{jw}}{M_j} \rho_w e^{-E_j/RT_w}$ ($j = 1,2,3,4,6,7$; c_{1w}/M_2 for U_3, U_6; c_{2w}/M_2 for U_1, U_2; c_{3w}/M_3 for U_7; c_{7w}/M_7 for U_4) and $U_5 = A_C(p_C^* - p_C)/\sqrt{2-RM_5T_w}$ (E_j-activation energy for j-th reaction, k_j- coefficient for j-th reaction, M_i- molecular weight of i-th mixture component, c_{iw} - mass concentration of i-th mixture component at body surface, T_w - temperature at body surface, R- universal gas constant, A_C ($0 \leq A_C \leq 1$) accommodation coefficient for graphite, p_C- partial pressure of carbon vapor, p_C^*- saturation pressure of carbon vapor, $i = 1,2,3,4,5,6,7$ referring to $O, O_2, N, N_2, C(gas), CO, CO_2$ respectively). Parameters of the air stream are determined from the system of Bernoulli's equation and equations of gas dynamics behind a shock wave in the earth's atmosphere. The temperature field in the body and the ablation rate are calculated by numerical solution of the equations of heat conduction and surface displacement respectively, for a cone with a 20° vertex angle made of VPP graphite in an air stream extending to an altitude $H_{oo} = 40{,}000$ m and moving at a velocity $V_{oo} = 7500$ m/s. Figures 4, tables 2, references 30: 27 Russian, 3 Western.
[284-2415]

UDC 533.72

HEAT TRANSFER FROM OR TO ELLIPTICAL CYLINDER IN GAS STREAM AT LOW PECLET NUMBER

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 1, Jan-Feb 82 (manuscript received 2 Dec 80) pp 31-34

SKACHKOV, I. M., SHCHUKIN, Ye. R. and YALAMOV, Yu. I., Moscow

[Abstract] The thermal flux distribution over the surface of an elliptical cylinder and the temperature distribution in the surrounding gas stream are calculated for the case of a low Peclet number, assuming uniform temperature distribution over the cylinder surface. The solution to the corresponding Oseen equation in elliptical coordinates, obtained in the form of series with modified Bessel functions of the second kind and Matthieu functions, is reduced to independent infinite systems of algebraic equations which yield expressions for the thermal flux $Q_T = N_u k(T_i - T_{oo})\frac{1}{2a}$ and the Nusselt number

$N_u = \frac{4\pi a/l}{\log(16a/N_{Pe}\gamma(a+b))}$ (k- thermal conductivity of cylinder material, T_i - temperature at cylinder surface, T_{oo} - temperature at infinity in gas stream, l- length of elliptical circumference, 2 - length of major axis, 2b- length of minor axis, $\log \gamma = 0.5722...$-Euler constant). Figures 2; references 4: 1 Russian, 3 Western.
[283-2415]

UDC 532

FORCED OSCILLATIONS OF FLUID IN CONTAINER

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 5, May 82 (manuscript received 29 Dec 79) pp 105-110

BELYAYEV, N. M., BEZUGLYY, V. Yu., MAKAROVA, A. S. and TOKAR', Yu. V., Dnepropetrovsk State University

[Abstract] The authors investigate forced oscillations of the free surface of an ideal fluid in a container with rectangular cross section and bottom of arbitrary shape moving horizontally in one direction. The two-dimensional kinematic and dynamic boundary conditions for the fluid are sipulated in terms of velocity and pressure respectively, those for the container are stipulated in terms of impermeability of its walls. The one-dimensional hydrodynamic problem is formulated including convection but disregarding the inertia force and assuming that the horizontal components of velocity are not functions of the vertical coordinate. The corresponding differential equations are reduced to difference equations and the latter are solved according to a homogeneous scheme with "frozen" coefficients in a time-space grid. Results of calculations are compared with cinegrams of the free surface of a fluid in containers with flat and spherical bottom respectively. Figures 4, references 4 Russian.
[282-2415]

UDC 534.1:532.5

DYNAMIC STABILITY OF FLEXIBLE BEAM IN LONGITUDINAL STREAM OF INCOMPRESSIBLE FLUID

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 3, Mar 82 (manuscript received 16 Oct 79) pp 108-112

PROKHOROVICH, V. A., PROKHOROVICH, P. A. (deceased) and SMIRNOV, L. V., Scientific Research Institute of Mechanics, Gor'kiy State University

[Abstract] A thin flexible beam with viscoelastic internal damping immersed lengthwise in a stream of incompressible fluid on hinge supports at both ends is under axial tension due to viscous forces and subject to transverse movements due to perturbations in the fluid. Its rectilinear mode of stability "in the small" is analyzed here, with the boundary conditions and the hydrodynamic force referred to the surface of a straight beam. The corresponding one-dimensional fourth-order partial differential equation for the beam deflection, which identically described the motion of the beam in two mutually orthogonal planes intersecting along the beam axis, and the Laplace equation for the fluid velocity potential are reduced to a boundary-value eigenvalue problem solvable in trigonometric series with MacDonald function coefficients,

through further reduction to an infinite system of homogeneous algebraic equations according to the Galerkin method. The solution reveals that loss of rectilinear stability occurs in form of aperiodically building up flexure, the mode of such a stability loss corresponding to the smallest eigenvalue. Figures 3, references 5: 2 Russian, 3 Western.
[281-2415]

STRESS CONCENTRATION IN INTERSECTING CYLINDRICAL SHELLS

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: MEKHANIKA in Russian Vol 35, No 2, Mar-Apr 82 (manuscript received 17 Sep 80) pp 43-52

YEL'TSOV, A. I., LIVSHITS, A. L. and MOLDAVSKIY, E. A., Scientific Research Institute at "Elektrotyazhmash" Plant, Khar'kov

[Abstract] An experimental stress study was made of two pairs of cylindrical shells forming a tee, a pair of steel shells and a pair of epoxy shells, the horizontal main member rigidly clamped around one base, its other end free, and the vertical branch member pointing with its free end upward. The stress distribution in the intersection was measured under ten different types of load: branch pipe loaded by axial force, transverse force in either of the two principal vertical (orthogonal) planes, bending moment in either or the two principal vertical (orthogonal) planes, or twisting moment; main pipe loaded by axial force, transverse force in the vertical principal plane, bending moment in the vertical principal plane, or twisting moment. The stress concentration factor was calculated for each case, as the ratio of maximum measured normal stress to nominal stress. Figures 11, tables 1, references 6: 1 Russian, 5 Western.
[279-2415]

UDC 539.31:534.1

CREEP AND FRACTURE OF OVAL PIPE UNDER EXTERNAL PRESSURE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 3, Mar 82 (manuscript received 27 Jan 81) pp 20-24

MATUSHKIN, V. L., technical aide, MATAYEV, G. A., candidate of technical sciences, docent, and BONDARENKO, Yu. D., candidate of technical sciences, docent

[Abstract] Creep and fracture of a thin steel pipe under external hydrostatic pressure at high temperature are analyzed as transient processes, taking into account that the original cross section is oval rather than circular due to manufacturing imprecision. Elastic strains are included and stresses are

assumed to be purely flexural, effect of tensile stresses on creep and compressive stresses altogether being disregarded without large error. The time to fracture is also calculated, formation of plastic hinges in most highly stressed section serving as criterion of fracture and the yield strength of the pipe material found on its tensile stress-strain curve for a given temperature. The results of calculation correlate closely with experimental data. Figures 2, references 6 Russian.
[275-2415]

UDC 539.3

STRESSED-STRAINED STATE OF REINFORCED SPHERICAL SHELLS TURNING INSIDE OUT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 3, Mar 82 (manuscript received 30 Dec 80) pp 11-14

KOROVAYTSEV, A. V., candidate of technical sciences, and PAPIROV, Ya. N., engineer

[Abstract] Stresses and strains in a spherical shell reinforced with discrete toroidal hoops and turning inside out under pressure are calculated on basis of the equation of equilibrium for an element of a reinforcing torus. The corresponding nonlinear boundary-value problem, with nonlinear boundary conditions and with compatibility conditions at points of contact on a given meridian, is reduced to a system of four differential and six complementary algebraic relations between displacements, forces and moments. It is solved first for a spherical dome without reinforcement and then for a shell with two reinforcing hoops, rigid joints and zero-moment joints being considered in the latter case. Figures 3, references 5: 2 Russian, 3 Western.
[275-2415]

UDC 621.822.7

MECHANISM OF BALL-BEARING SEIZURE IN VACUUM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 4, Apr 82 (manuscript received 28 Nov 80) pp 23-27

YURKOV, Yu. V., candidate of technical sciences

[Abstract] Seizure of a ball bearing is defined as its stalling due to a unlimited increase of friction torque and internal forces. Its mechanism is analyzed on the basis of a two-dimensional model of coplanar forces on a ball: normal reactions of separator, outer race and inner race, tangential friction on outer race on inner race. The model accounts for conditions of sliding along either race or both races, also conditions when loss of contact with the

outer race occurs. The coefficient of friction between ball and separator is found to be the governing parameter. Uniform rotation will continue after loss of contact when this parameter has a certain critical value depending on the bearing geometry, seizure will occur without sliding along the inner race when it is larger and no seizure will occur regardless of the friction between ball and races when it is smaller. The implication for bearing design is proper matching of ball and separator materials. Figures 3, references 3 Russian.
[271-2415]

UDC 534.832.53:629.11.02/09

ABATEMENT OF NOISE FROM VIBRATING SHEAVES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 6, Jun 82 (manuscript received 19 Oct 81) pp 73-75

FESINA, M. I., graduate student, and STAROBINSKIY, R. N., candidate of technical sciences, docent

[Abstract] A method of abatement of acoustic noise from vibrating pulleys mounted at the front of an automobile engine is proposed which combines simplicity with high effectiveness. It is based on treating a pulley as a sound radiating dipole and utilizing nearby engine surfaces as rigid sound reflecting and partially absorbing (with phase shift) walls. Calculation of sound power according to the method of images, taking into account structural limitations on proximity of wall to vibrating disk, indicate how the radiated sound power can be minimized. The feasibility of noise abatement by optimum spacing of the reflecting surface has been tested experimentally, and confirmed by analysis of 1/3 octave spectra in a model VAZ 2105 (Volga Automobile Plant) car. Figures 3, references 7: 5 Russian, 2 Western.
[274-2415]

UDC 539.214:539.374

EFFECT OF THERMAL FACTOR ON ULTIMATE EQUILIBRIUM OF SHELLS OF REVOLUTION

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 42, No 6, Jun 82 (manuscript received 9 Jun 81, deposited at All-Union Institute of Scientific and Technical Information No 191-82 Dep) p 1034

LISTROVA, Yu. P., POTAPOV, V. N. and PROKHOROVA, S. P.

[Abstract] The load capacity of a shell of revolution made of a rigidoplastic material under a symmetric load is calculated, taking into account different yield strengths in tension and in compression. The shell material is assumed

to be subject to the Prager plasticity condition describable by a hexagon in the plane of principal stresses. The mathematical model also considers a thermal factor, namely that the temperature profile across the shell thickness varies linearly in the axial direction and that both yield strengths depend on the temperature according to a simple inverse relation. A conical shell freely supported at its outer edge is considered as an example. References 3. [272-2415]

UDC 517.9:539.3

VIBRATIONS AND STABILITY OF SYSTEMS WITH PIECEWISE-VARIABLE DISTRIBUTION OF PARAMETERS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 82 (manuscript received 15 Jun 81) pp 43-47

STASYUK, M. F. and TATSIY, R. M., L'vov Polytechnic Institute

[Abstract] A general method is developed for obtaining the fundamental solution in series to quasi-differential equations of arbitrary order which describe vibrations of systems with piecewise-variable distribution of parameters. The method is based on a theorem, aided by three lemmas and followed by a corollary, pertaining to solutions to corresponding integro-differential equations. It is demonstrated on a second-order equation with piecewise-analytic coefficients. Article was presented by Academician Ya. S. Podstrigach, member UkSSR Academy of Sciences. References 8 Russian. [285-2415]

UDC 539.3

SUPERCRITICAL STRAINS IN SHALLOW SPHERICAL SHELLS UNDER EXTERNAL PRESSURE

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 82 (manuscript received 8 Jun 81) pp 41-43

PRICHKO, V. M., Physico-Technical Institute of Low Temperatures, UkSSR Academy of Sciences

[Abstract] For an experimental study of the supercritical state after loss of stability under external pressure, thin and shallow linearly elastic shells were produced by vacuum deposition of copper on convex spherical substrates (shell radius 100 mm, base radius 12.5 mm, wall thickness 0.033-0.067 mm, Young modulus 10^4 kg/mm^2) and clamped by two steel rings around the base. The shells were loaded by compressed air until they caved in, whereupon they were slowly returned to original shape by gradual relief of pressure. The critical

pressure was determined from the test results, measurements of depression radius and pressure difference across shell wall, and also calculated by solution of two equations of the corresponding boundary-value problem. Article presented by Academician A. V. Pogorelov, member UkSSR Academy of Sciences. Figures 4, references 3 Russian.
[285-2415]

UDC 534.1

BOUNDARY CONDITIONS FOR FLEXURAL VIBRATIONS OF BEAM WITH MOVING ELASTRO-INERTIAL CONSTRAINTS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 82 (manuscript received 23 Feb 81) pp 32-34

VESNITSKIY, A. I., and MANGOVA, V. N., Gor'kiy State University; Kiev State University

[Abstract] Boundary conditions for flexural vibrations of a beam rigidly clamped at both ends are examined in the case of an elasto-inertial constraint moving along it. A solution based on the Lagrange function for such a beam requires that an additional inertial component, formally a quasi-Coriolis force, be included in the balance of forces. This force, increasing proportionally to the velocity of the constraint, prevents the latter from reaching velocities equal to those of elastic waves propagating along the beam. Article was presented by Academician Yu. A. Mitropol'skiy, member UkSSR Academy of Sciences. Figures 2, references 7 Russian.
[285-2415]

UDC 539.3

ACCOUNTING FOR FRICTION IN THEORY OF CYLINDRICAL SHELL STACKS

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 82 (manuscript received 17 Sep 81) pp 50-54

SHOPA, V. M., POLEVOY, B. N. and VELICHKOVICH, S. V., Ivano-Frankovsk Sector of Structural Dynamics, Institute of Applied Problems in Mechanics and Mathematics, UkSSR Academy of Sciences

[Abstract] The state of stress and strain is calculated for a stack of cylindrical shells with friction between layers. Contact pressures are determined in the case of a stack in elastic equilibrium under uniform internal and nonuniform external pressure, on basis of three-dimensional theory with aid of Hooke's law and the Cauchy relation. A typical example is a stack of two thin shells of unequal thicknesses. Article was presented by Academician Ya. S. Podstrigach, member UkSSR Academy of Sciences. References 11 Russian.
[285-2415]

UDC 629.33.015.4

EXPERIMENTAL STUDY OF BEHAVIOR OF REINFORCED SHELL UNDER INTERNAL PRESSURE AND PURELY FLEXURAL IMPACT LOAD

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 5, May 82 (manuscript received 29 Feb 80) pp 114-118

AGAMIROV, V. L. and WO MIN KAM, Moscow

[Abstract] Theoretical analysis of a reinforced cylindrical shell under internal pressure and flexural impact, assuming smooth anisotropy with initial and elastic deflections described by second-degree trigonometric polynomials, is supplemented with experimental data on shells made of 30KhGSA strip steel. Impact loads at various initial velocities are applied in a special machine, internal pressure is produced with air. Increasing the impact velocity resulted in a larger number of depressions with higher-order modes of stability loss and raised the critical load level. Increasing the internal pressure also raised the critical level of impact load. The results agree with theoretical ones and confirm the reinforcing effect of static internal pressure. Figures 5, tables 1, references 1 Russian.
[282-2415]

UDC 539.3

STRESSED AND STRAINED STATE OF CYLINDRICAL FILAMENT-WOUND LAMINATED SHELLS UNDER INTERNAL PRESSURE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 5, May 82 (manuscript received 20 Jan 81) pp 111-114

ODINETS, A. R., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Stresses and strains in a cylindrical filament-wound laminated shell under internal pressure are calculated, assuming that the net tangential force between layers does not exceed the Coulomb friction force. The number of layers (turns) is arbitrary, the inner end and the outer end of the spiral are fastened to the respective adjacent layers (turns). The corresponding differential equation of equilibrium for an elementary ring segment is solved after replacement of the discontinuous function in it with a piecewise-uniform one in each layer. Calculations are confined to the elastic range. Results are shown for a friction coefficient ranging from 0.1 to 0.3 in a triple-layer shell. Figures 1, references 7 Russian.
[282-2415]

UDC 624.074.4.042.8

DYNAMICS OF BRANCHED SHELL STRUCTURES

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 5, May 82 (manuscript received 21 Dec 79) pp 49-56

MYACHENKOV, V. I. and PAVLOV, E. K., Moscow

[Abstract] Natural modes of vibration of compound shell structures with reinforcing hoops under dynamic load are calculated, assuming the hoops to be nondeformable and the component shells to satisfy the Kirchhoff-Love hypotheses. The state of stress and strain is represented as the sum of an axisymmetric nonlinear static one and a linear dynamic one, the latter resulting from small nonaxisymmetric oscillations about the former. The corresponding homogeneous system of differential equations, with physical and geometrical relations as well as given boundary conditions for each component shell, is supplemented with the stiffness matrix and reduced to a system of algebraic equations. The general procedure is applied to the case of a dynamic load varying arbitrarily in time and along the space coordinates. The algorithm has been programmed in PL/1 with the use of standard routines for a YeS-1050 "Unified System" computer. Results are shown for a closed spherical shell with the mass concentrated at one pole and a loading pulse of internal pressure uniformly distributed over the surface. Figures 5, references 4 Russian.
[282-2415]

UDC 539.3

NUMERICAL SOLUTION OF NONAXISYMMETRIC PROBLEMS IN NONLINEAR THEORY OF MULTI-LAYER SHELLS OF REVOLUTION

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 5, May 82 (manuscript received 16 Mar 81) pp 43-48

GRIGORENKO, Ya. M. and TIMONIN, A. M., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A method is proposed for calculating geometrically nonlinear strains in circumferentially closed multilayer shells of revolution under nonaxisymmetric local loads Low stiffness in shear is assumed and transverse shearing strains are included according to a Timoshenko-type model. The complete fundamental system of equations describing transverse shear, equilibrium and elasticity relations in a temperature field is reduced to a resolvent system of 10 first-order nonlinear partial differential equations containing trigonometric functions expanded on series (2N+ 1 terms) and then to a system of 10(N+ 1) first-order nonlinear ordinary differential equations. The latter is solved numerically, for the appropriate boundary conditions,

by the method of simple iteration. The three-step algorithm has been programmed in ALGOL-GDR for a BESM-6 computer. Numerical results are shown for an orthotropic cylindrical shell of uniform wall thickness on hinge supports and under a lateral load cosinusoidally distributed over the circumference. Figures 2, tables 1, references 10 Russian.
[282-2415]

UDC 539.3:534.1

PROPAGATION OF AXISYMMETRIC WAVES IN DOUBLE-LAYER CYLINDRICAL SHELL WITH FINITE STIFFNESS IN SHEAR

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 3, Mar 82 (manuscript received 3 Apr 81) pp 128-131

IVANOV, Yu. A., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] Propagation of an axisymmetric harmonic wave in a double-layer cylindrical shell is calculated without use of kinematic hypotheses and without series expansion over the thickness. The corresponding two-dimensional problem in the theory of elasticity is reduced to a two-dimensional one on basis of the generalized shear model. The system of equations of motion becomes a closed one by virtue of a uniform state of stress and strain. The solution yields the dispersion equation as well as the dependence of dimensionless phase velocity and group velocity on the wave number. Figures 2, references 11: 8 Russian, 3 Western.
[281-2415]

UDC 539.3

PROPAGATION OF HARMONIC WAVES IN BODIES WITH INITIAL STRAINS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 3, Mar 82 (manuscript received 30 Dec 80) pp 126-128

MAKHORT, F. G., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Propagation of plane harmonic waves in a predeformed body is analyzed, assuming an initially isotropic body and then considering the general case of principal strains in directions other than those of the coordinate axes. The linearized equations of motion, with zero displacements at the body surface as the boundary conditions, yield a frequency equation for the phase velocities of waves which has generally three roots corresponding respectively to one quasi-longitudinal and two quasi-transverse waves. In the case of propagation along any principal initial strain this equation splits into two, one describing a longitudinal wave and the other describing two quasi-transverse ones. References 8: 6 Russian, 2 Western.
[281-2415]

UDC 531.3

APPROACH TO ACTIVE MEANS OF VIBRATION PROOFING

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 3, Mar 82 (manuscript received 31 Dec 80) pp 97-101

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[Abstract] Active means of protecting movable mechanical systems against dynamic overloads are proposed, namely minimization of such overloads on the elastic components through a optimization of control. A system is described by the equations $\dot{x}_1 = x_2$, $\dot{x}_2 = u$, $\dot{x}_{2k+1} = \dot{x}_{2k+2}$, $x_{2k+2} = -\Omega_k^2 x_{2k+1} + a_k u$ ($k = 1,\ldots,N$) and is to be moved from point $x_1(0) = 0$ ($i = 1,\ldots,2N+2$) to point $x_1(T) = X$, $x_2(T) = V$, $x_{2k+1}(T) = U_{2k+1}$, $x_{2k+2}(T) = 0$ ($k = 1,\ldots,N$) with minimization of the quadratic criterion functional

$$J = 1/2 \int_0^T \sum_{k=1}^{N} \ddot{x}_{2k+2}^2(t) w_k dt$$

(w_k - weight factors, $x_{2k+2}(t)$- accelerations of elastic components in generalized coordinates). An analytical solution is possible for systems with quasi-static deformation. It is obtained for the case of no constraints on control and phase variables. A solution for the case of constraints on control and one phase variable is obtained in dimensionless variables and with minimum involvement of numerical methods, to facilitate a comprehensive analysis of results and establish the feasibility limits of this vibration proofing technique. Figures 4, references 4 Russian.
[281-2415]

UDC 534.1:539.3

DYNAMIC INSTABILITY OF CIRCULAR CYLINDRICAL SHELLS WITH INITIAL DEFLECTION

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 3, Mar 82 (manuscript received 21 Nov 80) pp 28-33

KOVAL'CHUK, P. S., KRASNOPOL'SKAYA, T. S. and PODCHASOV, N. P., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Dynamic instability of thin circular cylindrical shells under periodic axial loads is considered and an attempt is made to reconcile differences between theory and experiment, the latter indicating a wider zone of parametric resonances. The problem is therefore treated theoretically again, but on basis of an approximate solution for shells with small initial deflections. The corresponding system of two differential equations is solved

for deflections, with the unknown coefficients (deflection functions) in the infinite trigonometric series expansion characterizing the natural vibration modes and determined according to the Bubnov-Galerkin method in generalized coordinates. Calculations made for a shell on hinge supports at both ends indicate that, indeed, an imperfect shell has a wider dynamic range than an ideal one. The vibration amplitudes in this range depend also on nonlinear elastic and dissipative forces in the system. Figures 4, references 9 Russian. [281-2415]

UDC 539.3

TRAVELING WAVES IN STRUCTUALLY ORTHOTROPIC CYLINDRICAL SHELL

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 18, No 3, Mar 82 (manuscript received 22 Nov 80) pp 22-27

ZARUTSKIY, V. A., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A closed circular cylindrical shell with an orthogonal regular mesh of reinforcing members is considered and the effect of eccentricity of these members (relative to the median surface of the shell) on the parameters of longitudinal waves in the shell is analyzed, assuming that their number is sufficiently large for the entire structure to be treated as an orthotropic shell. The equations of motion are derived on the basis of Kirchhoff-Love hypotheses for the shell proper and Kirchhoff-Clebsch hypotheses for one-dimensional elastic reinforcing members. The problem is reduced to two homogeneous systems of linear algebraic equations in displacements with the same determinant, which equated to zero yields the dispersion equation. The latter is examined for circumferential space harmonics of orders $n = 0$ (one sixth-degree equation for longitudinal flexural waves, one fourth-degree equation for pure shear waves), $n \geq 1$ (eighth-degree equation after disregarding inertia forces and flexural stiffness of reinforcing members in plane tangential to median surface of shell proper) and $n \geq 2$ (asymptotic solution, two fourth-degree equations for small n and low frequency of load harmonic). Both hopes and stringers, on the inside surface or on the outside surface, are considered and the critical load frequencies are established in each case with a subsequent analysis of wave formation in the various ranges of load frequency. Figures 3, references 6: 4 Russian, 2 Western. [281-2415]

UDC 620.1

RESISTANCE OF METAL OF TURBINE RUNNER TO LOW-CYCLE FATIGUE AFTER LONG SERVICE

Moscow TEPLOENERGETIKA in Russian No 6, Jun 82 pp 57-60

TRUKHNIY, A. D., candidate of technical sciences, MARTYNOV, Yu. D., candidate of technical sciences, GINZBURG, E. S., candidate of technical sciences, and REZINSKIKH, V. F., engineer, Moscow Institute of Power Engineering and All-Union Thermotechnical Institute

[Abstract] The runner in the medium-pressure cylinder of a K-200-130 turbine was tested for low-cycle fatigue of the metal (R2MA steel) after 54,700 hours of operation with 240 starts (including 120 cold starts). Samples were cut from disks of the 14th stage (operating temperature 518°C) and the 18th stage (operating temperature 388°C) and examined. The mechanical properties of the 18th stage had not changed, while tensile strength and 0.2% yield strength of the 14th stage had decreased. Microstructually the metal has remained constituted of bainite with free ferrite and carbides, the ferrite content varying along the disk radius. Fatigue tests were performed in the strain-symmetric tension-compression mode at constant temperature T= 550°C. Low-cycle life was evaluated according to the Coffin relation for plastic strains and statistically analyzed according to the Bartlett criterion. The relation between strain and stress amplitudes per half-cycle was approximated with the $\Delta\varepsilon = \frac{\Delta\sigma}{E} + \frac{\Delta\sigma_y}{E}\left(\frac{\Delta\sigma}{\Delta\sigma_y}\right)^m$ law. The results indicate that, except for an approximately 10% and not very significant drop of yield strength, the fatigue resistance of runner disks has not decreased. Fatigue defects were found concentrated in 100-150 μm thick subsurface layer of expansion grooves, and periodic removal of such a layer during overhaul should completely restore the fatigue resistance of a runner. Figures 6, tables 4, references 5 Russian. [278-2415]

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